

Coastal and Continental Shelf Processes in Ghana

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LONG-TERM GOALS

The long-term goal is the establishment of a centre of excellence for coastal and continental shelf research program in Ghana, through capacity development of researchers to contribute to international research efforts, and formulation of science-based policies for coastal area management. The program would also enhance maritime security and governance capacities of the Gulf of Guinea nations. Research programs are focused on medium-scale impacts (i.e. shoreline evolution), assessment of meso-scale continental shelf events (i.e. upwelling), and analyses of satellite imageries for Maritime Domain Awareness (MDA).

OBJECTIVES

1. To carry out a wide range of *in situ* measurements in the nearshore zone to facilitate investigation into shoreline change in Ghana
2. To develop capability in analyses of Synthetic Aperture Radar (SAR) imageries to complement research in coastal processes, including detection and analysis of oil spills and maritime traffic in the Gulf of Guinea
3. To investigate the upwelling dynamics in the Gulf of Guinea with the purpose of developing a model to simulate this phenomenon. Performance of existing coupled atmospheric-ocean models with meso-scale resolution would be assimilated with data for forecasting.

APPROACH

The coastline of Ghana measures about 550 km and is generally a low-lying area not exceeding 200 m above mean sea level. It is bordered by a narrow continental shelf extending outwards between 30 and 90 km. Significant sections of Ghana's coast are experiencing relatively high rates of erosion, which has destroyed coastal infrastructure, collapsed industries and threatened the ecosystem (Appaning Addo *et al.*, 2008). Understanding changes to sediment transport within the micro and macro littoral cells is critical to forecasting future shoreline positions under different climate change scenarios (Boateng, 2006). This will reveal the potential impact of erosion on the local economy, and enable development of sustainable management strategies.

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Generally, mitigation efforts in Ghana have been *ad hoc* in approach, requiring in-depth research to understand causal mechanisms in order to provide solution to coastal managers. Limited expertise and inadequate infrastructure for field surveys have been a major constraint over the years. These issues are being resolved by this research initiative.

This fiscal year was primarily devoted to acquisition of relevant field instruments, identification of local scientists, and development of appropriate strategies to sustain a long-term research program in the region. The University of Ghana (UG) is the lead institution, and is collaborating with other key governmental institutions in this research initiative (i.e. Hydrological Services Division, Environmental Protection Agency, Ghana Survey Department, Geological Services Department, Ghana Ports and Harbors Authority and Ghana Army Engineers Regiment). Selected scientists from these institutions were taken through series of training to develop requisite skills in experimental designs, field measurements and data analytical techniques. Experts from United States and Europe (i.e. University of New Hampshire, United States Geological Services, Woods Hole Oceanographic Institute, and UNESCO-IHE of Netherlands), provided in-depth field training on differential Real-Time Kinematic GPS-based surveys, in the surf zone and onto the beach face, video-based measurements of waves, bathymetry mapping, among others.

The coastal processes research program is being carried out at different spatial scales – (1) large scale coastline development of order 100 - 1000 km, (2) large scale shelf processes of order 100 - 1000 km, (3) large scale nearshore processes of order 10 - 100 km, and (4) medium scale coastal inlets and adjacent beaches of order 1 - 10 km.

WORK COMPLETED

Comprehensive program to investigate nearshore processes has been designed for Ghana. This was achieved following series of training workshops, combined with field surveys, involving Ghanaian scientists and counterparts from Europe and America. Thirty-three (33) ground control points have been established along the entire coastline, and coordinated to the Ghana grid (Figure 1). This is serving as reference points for on-going beach profiling and bathymetric survey to create a digitized baseline of the coastline. Equipment acquired during the fiscal year includes differential GPS, five hand-held GPS, echosounder, eight high-performance computers and a server, two field laptops, and video camera.

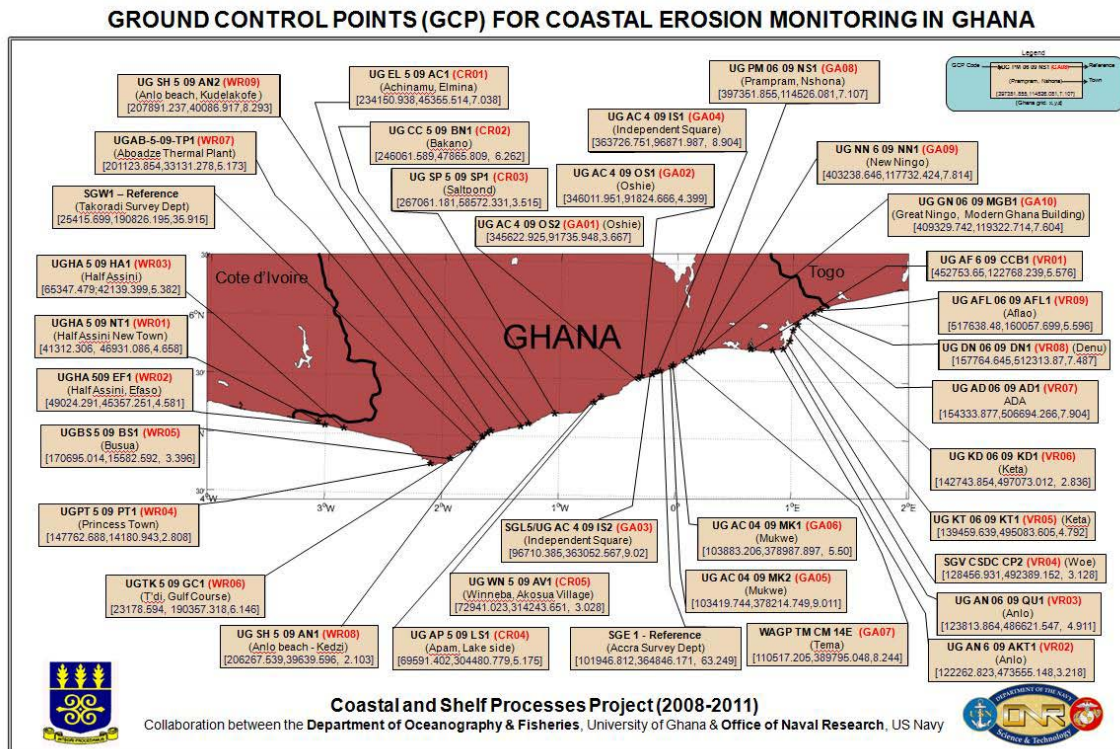


Figure 1. Established ground control points for implementation of a coastal research program in Ghana (as designed and printed in Remote Sensing Laboratory - UG)

RESULTS

Field deployments of Real-Time Kinematic Global Positioning System (RTK-GPS) equipment and reconnaissance mapping using WHOI's Ground-Penetrating Radar (GPR) was conducted to assess coastal hazards and processes along the coast. Preliminary results showed some significant hazard areas along low-lying coastal barriers and regions that have experienced anthropogenic change, such as harbor construction and disruption in sediment supply (Ashton, 2009). There are also significant erosion problems where coastal bluffs consist of weak and friable material. The significant changes along the Volta Delta to the east are complex, yet could be attributable to both natural delta evolution processes and changes in the sediment supply from the dammed Volta River. Recommendations for short-term future research emphasized the need for accurate quantification of historical shoreline change trends, and appraisal of large-scale coastal sediment budgets.

Ocean temperature profiles from Argo floats from the equatorial Atlantic were analysed to estimate the mixed layer depth and associated thermal variability within 0 - 500m depth. In the Gulf of Guinea, 22°C cold water at the 30m depth flows from the south onto the Ghana-Cote d'Ivoire continental shelf, indicating the potential source of nutrient rich bottom water that nourishes the Mixed Layer Depth (MLD), and drives biological production (Figure 2). The MLD was shallow at the east and relatively deeper at the western end of the equatorial Atlantic. Variability in the MLD can be associated with variations in the westward flow of the warm and saline Equatorial Undercurrent. Further warming of the equatorial Atlantic has a potential of increasing the MLD and affecting upper ocean surface processes.

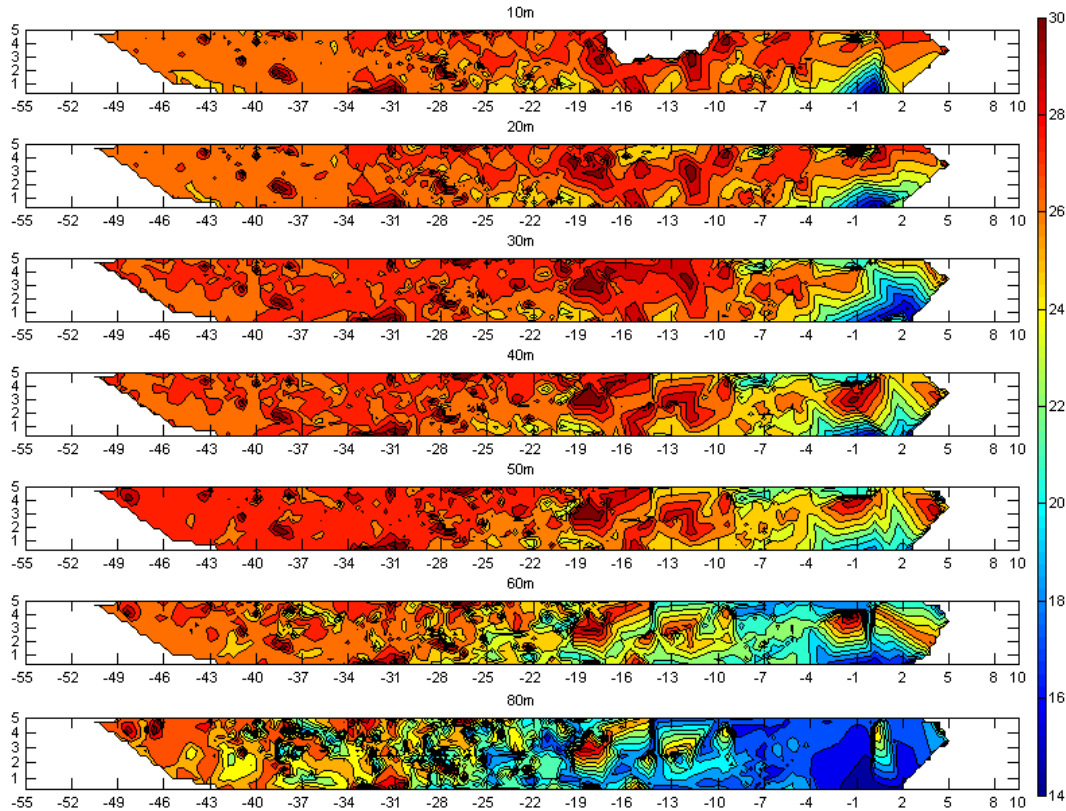


Figure 2. Subsurface temperature distribution of the equatorial Atlantic created by linear interpolation of median temperature from $0.3^\circ \times 0.3^\circ$ binned Argo profiles between January 2000 to April 2009.

IMPACT/APPLICATIONS

Science and technology development in coastal processes through research and training in West Africa is greatly constrained as result of limited expertise and lack of infrastructure. The current initiative gives very positive indication towards establishment of a centre of excellence for sustained research into coastal processes in the region. The effort at building capacity in theoretical knowledge, numerical model development and execution, satellite imagery analysis, and field observation techniques, processing, and assimilation of data with models would enable local scientists to contribute meaningfully to international research efforts.

The program has also generated keen interest and enthusiasm among local scientists. This has resulted in the enrolment of three persons for graduate programs in the University of Ghana. Four other persons from different institutions are also in the process of developing their PhD research topics in line with the project objectives.

RELATED PROJECTS

The Department of Oceanography is hosting DevCoCast – a project that provides selected developing countries to receive wide range, low resolution satellite data streams in delayed and near real time modes, using C-band dish. The DevCoCast setup is linked to a global network of satellite-based data dissemination systems via Atlantic Bird-3. This system overcomes the high constrain imposed by existing low bandwidth for internet connectivity. DevCoCast only provides a means for satellite data acquisition and does not conduct any pure S&T research. However, the current ONR-funded project has equipped the Remote Sensing laboratory and also developed the requisite human skills for carrying out research using data provided by DevCoCast.

(http://www.eumetsat.eu/Home/Main/AboutEUMETSAT/InternationalRelations/Africa/SP_1235664773918)

The above activity is directly linked to another investigation on the evaluation of primary productivity in the Gulf of Guinea under the Guinea current Large Marine Ecosystem Project

(<http://www.gclme.org>)

The current project is also helping to deploy drifter floats as part of the Global Drifter Program for monitoring temperature, salinity, and velocity of the upper ocean. One person has developed skills in downloading and analysing Argo data and using it as part of the continental shelf processes research to investigate the upwelling phenomenon. (<http://www.argo.ucsd.edu/>)

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